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NAGAWICKA LAKE, WAUKESHA COUNTY, WISCONSIN

Pacific Northwest Environmental Research Laboratory

Prepared for:

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Wisconsin National Guard

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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REPORT

ON

NAGAWICKA LAKE

WAUKESHA COUNTY

WISCONSIN

EPA REGION V

WORKING PAPER No. 43

WITH THE COOPERATION OF THE

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

AND THE

WISCONSIN NATIONAL GUARD

NOVEMBER, 1974

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wisconsin Department of Natural Resources for professional involvement and to the Wisconsin National Guard for conduct of the tributary sampling phase of the Survey.

Francis H. Schraufnagel, Acting Assistant Director, and Joseph R. Ball of the Bureau of Water Quality, and Donald R. Winter, Lake Rehabilitation Program, provided invaluable lake documentation and counsel during the Survey. Central Office and District Office personnel of the Department of Natural Resources reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

Major General James J. Lison, Jr., the Adjutant General of Wisconsin, and Project Officer CW-4 Donald D. Erickson, who directed the volunteer efforts of the Wisconsin National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

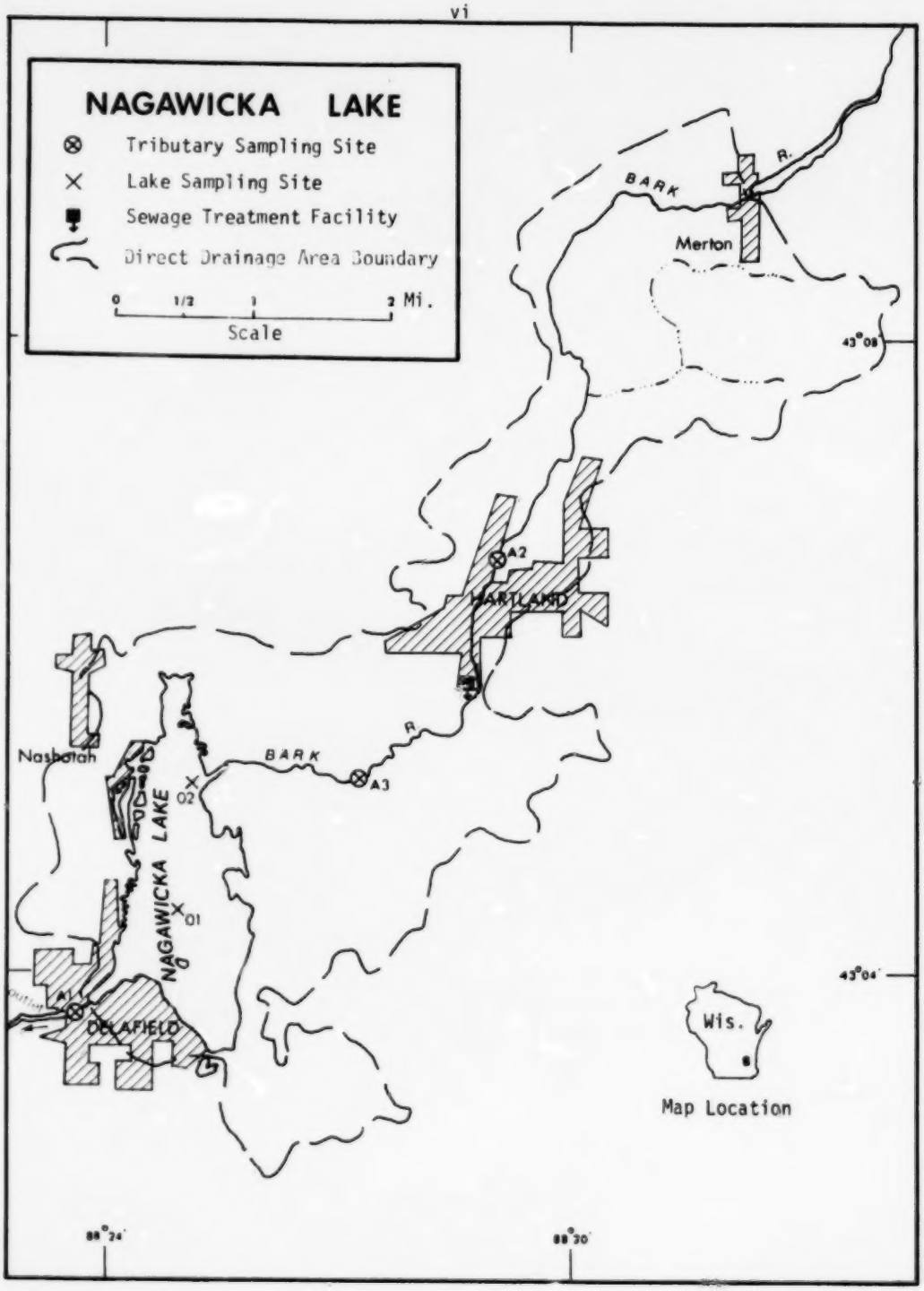
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WISCONSIN

LAKE NAME	COUNTY
Altoona	Eau Claire
Beaver Dam	Barron
Beaver Dam	Dodge
Big Eau Pleine	Marathon
Browns	Racine
Butte des Morts	Winnebago
Butternut	Price, Ashland
Castle Rock Flowage	Juneau
Como	Walworth
Crystal	Vilas
Delavan	Walworth
Eau Claire	Eau Claire
Geneva	Walworth
Grand	Green Lake
Green	Green Lake
Kegonsa	Dane
Koshkonong	Jefferson, Rock, Dane
Lac La Belle	Waukesha
Middle	Walworth
Nagawicka	Waukesha
Oconomowoc	Waukesha
Okauchee	Waukesha
Petenwell Flowage	Juneau
Pewaukee	Waukesha
Pigeon	Waupaca
Pine	Waukesha
Poygan	Winnebago, Waushara
Rock	Jefferson
Rome Pond	Jefferson, Waukesha
Round	Waupaca
Shawano	Shawano

LAKE NAME	COUNTY
Sinnissippi	Dodge
Swan	Columbia
Tainter	Dunn
Tichigan	Racine
Townline	Oneida
Trout	Vilas
Wapogassett	Polk
Wausau	Marathon
Willow	Oneida
Winnebago	Winnebago, Fond Du Lac, Calumet
Wisconsin	Columbia
Wissota	Chippewa
Yellow	Burnett


NAGAWICKA LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Boundary
0 1/2 1 2 Mi.
Scale
BARK R.
Merton
43°08'
A2
HARTLAND
Nashotah
BARK R.
A3
02
NAGAWICKA LAKE
01
A1
DELAFIELD
43°04'
Wis.
Map Location
88°24'
88°30'

NAGAWICKA LAKE

STORET NO. 5531

I. CONCLUSIONS

A. Trophic Condition:

Survey data and the records of others show that Nagawicka Lake is eutrophic.

B. Rate-Limiting Nutrient:

Algal assay results are not indicative of the rate-limiting nutrient because of a significant loss of phosphorus in the sample. The lake data indicate nitrogen limitation at all sampling times.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Nagawicka Lake received a total phosphorus load at a rate well in excess of that proposed by Vollenweider (in press) as "dangerous"; i.e., a eutrophic rate (see page 15). It is estimated that the Village of Hartland contributed just over 56% of this load. This estimate may be too conservative; the P load in the Bark River at A-3, below the STP, minus the load at A-2, above the STP, is nearly 7,500 lbs, or 61% of the total phosphorus load for the sampling year. Also, using limited nutrient and flow data obtained in 1969 by the Wisconsin Department of Natural Resources (McKersie, et al., 1971), it is calculated that Hartland was discharging about 8,000 lbs of phosphorus per year at that time.

However, considering only the conservative estimate, the total phosphorus loading rates that can be achieved by specified levels of phosphorus removal at the Hartland STP, as compared to Vollenweider's suggested rates, are:

	Total P Loading Rate	
% P Removal	lbs/acre/yr	$g/m^2/yr$
Existing	11.9	1.33
50	8.5	0.95
70	7.1	0.80
80	6.5	0.72
90	6.8	0.65
100	5.1	0.57
Vollenweider:		
"Dangerous" (eutrophic rate)		0.50
"Permissible" (oligotrophic rate)		0.25

None of the removal options would result in a loading rate less than "dangerous", assuming the load estimated for Hartland is correct. However, if the load indicated by the difference in stream loads (i.e., 7,500 lbs) is more accurate, 100% removal would result in a loading rate of 4.5 lbs/acre/yr or 0.50 $g/m^2/yr$.

Presently, the Village of Hartland is proposing a connection to new treatment facilities to be constructed at the City of Delafield with effluent discharge to the Bark River below Nagawicka Lake. It appears that this action would result in at least

some improvement of the trophic condition of the lake after a new nutrient equilibrium becomes established.

2. Non-point sources (see page 15)--The estimated phosphorus export of the Bark River during the sampling year was appreciably higher than that calculated for unimpacted Otter Creek (74 lbs/mi^2/yr), tributary to Lake Koshkonong elsewhere in the Rock River drainage. Considering that the Bark River was sampled near the headwaters, the higher export probably resulted from underestimation of the point-source load.

II. INTRODUCTION

Nagawicka Lake is located in the upper portion of the Bark River subdrainage in the lower Rock River drainage in the glaciated southeastern part of Wisconsin. Land use in the drainage is predominately agricultural.

The primary uses of the lake are recreational; these include swimming, boating, and fishing. Game fish present are northern pike, walleyes, large- and smallmouth bass, and panfish. Reportedly, fishing is good, but weeds constitute a major use problem (Poff and Threinen, 1963).

Much of the shoreline is privately owned, but public access is provided. The county park on the east side of the lake provides excellent access for multiple uses. Commercial facilities are available.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry*:

1. Surface area: 1,026 acres.
2. Mean depth: 32.5 feet.
3. Maximum depth: 90 feet.
4. Volume: 33,358 acre/feet.
5. Mean hydraulic retention time: 1.5 years.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area†	Mean flow†
Bark River	34.9 mi^2	23.3 cfs
Minor tributaries & immediate drainage -	8.1 mi^2	6.7 cfs
Totals	43.0 mi^2	30.0 cfs

2. Outlet -

Bark River	44.6 mi^{2}††	30.0 cfs

C. Precipitation†††:

1. Year of sampling: 38.7 inches.
2. Mean annual: 30.7 inches.

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* Dept. of Natural Resources lake survey map (1955).
† Drainage areas are accurate within ±0.5%; mean daily flows are accurate within ±40%; mean monthly flows are accurate within ±35%; and normalized monthly flows are accurate within ±35%.
†† Includes area of lake.
††† See Working Paper No. 1, "Survey Methods".

IV. LAKE WATER QUALITY SUMMARY

Nagawicka Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at station 1 (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 75 feet at station 1 and 4 feet at station 2.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was esentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (11/10/72)		
Temperature (Cent.)	5.8	7.2	7.5	7.5
Dissolved oxygen (mg/l)	0.0	6.9	8.3	8.4
Conducitivity (μmhos)	520	565	520	700
pH (units)	7.4	7.8	7.9	7.9
Alkalinity (mg/l)	210	242	222	320
Total P (mg/l)	0.119	0.156	0.124	0.374
Dissolved P (mg/l)	0.103	0.139	0.113	0.330
NO_2 + NO_3 (mg/l)	0.100	0.719	0.250	2.540
Ammonia (mg/l)	0.260	0.447	0.330	1.400
		ALL VALUES		
Secchi disc (inches)	36	76	54	161

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/21/72	1. Anabaena	3,924
	2. Melosira	470
	3. Dinobryon	362
	4. Navicula	72
	5. Cryptomonas	72
	Other genera	236
	Total	5,136
08/19/72	1. Chroococcus	994
	2. Fragilaria	783
	3. Dinobryon	783
	4. Melosira	572
	5. Anabaena	512
	Other genera	2,470
	Total	6,114
11/10/72	1. Flagellates	663
	2. Anabaena	402
	3. Fragilaria	341
	4. Chroococcus	191
	5. Scenedesmus	71
	Other genera	1,434
	Total	3,102

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/21/72	01	36.7
	02	3.3
08/19/72	01	11.5
	02	15.5
11/10/72	01	2.3
	02	2.9

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.069	1.134	21.7
0.006 P	0.075	1.134	22.8
0.012 P	0.081	1.134	24.2
0.024 P	0.093	1.134	25.3
0.060 P	0.129	1.134	26.0
0.060 P + 10.0 N	0.129	11.134	58.9
10.0 N	0.069	11.134	26.7

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Nagawicka Lake was quite high at the time the sample was collected despite a loss of over half of the dissolved phosphorus (74 µg/l) between the time of sample collection and the beginning of the assay.

The assay results indicate phosphorus limitation; however, had the phosphorus loss not occurred, the sample would have been nitrogen limited. The lake data indicate an N/P ratio of 8/1 at the time the assay sample was collected; i.e., nitrogen limitation would be expected. The N/P ratios at the other sampling times were 5/1 or less.

D. Trophic Condition:

Survey data and the records of others (Ketelle and Uttormark, 1971) show that Nagawicka Lake is eutrophic. Wisconsin Department of Natural Resource records show that the lake has been chemically treated for algae and weed control almost every year since 1950 (Lueschow, 1972), and Survey limnologists noted the occurrence of heavy growths of aquatic vegetation, particularly in the northern end of the lake.

Of the 46 Wisconsin lakes studied, 34 had less mean total phosphorus, 37 had less mean dissolved phosphorus, 40 had less mean inorganic nitrogen, and only three lakes had a higher algal assay control yield.

Marked depression of dissolved oxygen with depth was evident at station 1 in June and August of 1972, and oxygen was depleted near the bottom in November, 1972.

V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Wisconsin National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff months of April and May when two samples were collected. Sampling was begun in September, 1972, and was completed in August, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Wisconsin District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were calculated using the mean concentrations in the Bark River at station A-2 and the mean ZZ flow.

The Village of Hartland declined participation in the Survey, and nutrient loads were estimated at 2.5 lbs P and 7.5 lbs N/capita/year. The loads attributed to the Bark River at station A-3 do not include the estimated Hartland STP loads.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Hartland	2,763*	Act. sludge	0.175**	Bark River

2. Known industrial** -

Name	Product	Treatment	Mean Flow (mgd)	Receiving Water
Sealtite Mfg. Corp., Merton†	insulation	(cooling water)	?	Bark River

* 1970 Census.
** McKersie, et al., 1971.
† Not a source of nutrients.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Bark River	3,900	32.1
b. Minor tributaries & immediate drainage (non-point load) -	820	6.7
c. Known municipal -		
Hartland	6,910	56.8
d. Septic tanks* -	370	3.1
e. Industrial -		
None known	-	-
f. Direct precipitation** -	160	1.3
Total	12,160	100.0

2. Outputs -

Lake outlet - Bark River 5,250

3. Net annual P accumulation - 6,910 pounds.

* Estimated; one park, one camp, and ca. 490 dwellings on lakeshore (see Working Paper No. 1).
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Bark River	143,120	64.8
b. Minor tributaries & immediate drainage (non-point load) -	33,580	15.2
c. Known municipal -		
Hartland	20,720	9.4
d. Septic tanks* -	13,450	6.1
e. Industrial -		
None known	-	-
f. Direct precipitation** -	9,880	4.5
Total	220,750	100.0

2. Outputs -

Lake outlet - Bark River 93,890

3. Net annual N accumulation - 126,860 pounds.

* Estimated; one park, one camp, and ca. 490 dwellings on lakeshore (see Working Paper No. 1).
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Sub-drainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr
Bark River	112	4,101

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenwieder (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Units	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
lbs/acre/yr	11.9	6.7	215.2	123.6
grams/m^2/yr	1.33	0.75	24.1	13.9

Vollenweider loading rates for phosphorus (g/m^2/yr) based on mean depth and mean hydraulic retention time of Nagawicka Lake:

"Dangerous" (eutrophic rate)	0.50
"Permissible" (oligotrophic rate)	0.25

VI. LITERATURE REVIEWED

Anonymous, 1972. Wisconsin lakes. Publ. 218-72, Dept. of Natural Resources, Madison.

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VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR WISCONSIN 9/30/74

LAKE CODE 5531 NAGAWICKA LAKE

TOTAL DRAINAGE AREA OF LAKE 44.60

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
5531A1	44.60	19.50	19.50	45.90	64.40	39.00	47.80	21.50	15.60	19.50	20.50	27.30	19.50	29.98
5531A3	34.90	15.00	15.00	37.00	51.00	30.00	36.00	17.00	12.00	15.00	16.00	22.00	14.00	23.32
5531ZZ	9.70	4.40	4.20	10.00	14.00	8.80	11.00	4.80	3.40	4.40	4.60	6.20	4.30	6.67

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 44.60
SUM OF SUB-DRAINAGE AREAS = 44.60

TOTAL FLOW IN = 360.10
TOTAL FLOW OUT = 360.00

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5531A1	9	72	36.00	23	61.00				
	10	72	45.00	14	38.00				
	11	72	34.00						
	12	72	11.00	9	10.00				
	1	73	74.00						
	2	73	50.00	11	84.00				
	3	73	130.00	18	170.00				
	4	73	150.00	14	100.00	29	100.00		
	5	73	120.00	12	130.00	28	150.00		
	6	73	53.00	16	51.00				
	7	73	19.00	1	25.00				
	8	73	8.80	26	7.40				
5531A3	9	72	27.00	23	46.00				
	10	72	34.00	14	29.00				
	11	72	26.00						
	12	72	8.60	9	7.50				
	1	73	59.00						
	2	73	40.00	11	68.00				
	3	73	100.00	18	140.00				
	4	73	120.00	14	82.00	29	82.00		
	5	73	96.00	12	100.00	28	120.00		
	6	73	41.00	16	39.00				
	7	73	15.00	1	19.00				
	8	73	6.40	26	5.40				
5531ZZ	9	72	6.40	23	11.00				
	10	72	7.80	14	6.70				
	11	72	5.90						
	12	72	2.00	9	1.70				
	1	73	18.00						
	2	73	12.00	11	20.00				
	3	73	31.00	18	42.00				
	4	73	34.00	14	24.00	29	24.00		
	5	73	28.00	12	30.00	28	36.00		
	6	73	11.00	16	10.00				
	7	73	3.70	1	4.70				
	8	73	1.30	26	1.10				

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APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/09/30

553101
43 04 06.0 088 23 24.0
LAKE NAGAWICKA
55 WISCONSIN

11EPALES
3

2111202
0070 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/21	06	35 0000	14.6	8.8	66	420	8.60	185	0.050	0.090	0.037	0.017
	06	35 0015	15.2	8.6		425	8.30	192	0.030	0.050	0.031	0.020
	06	35 0025	9.8	6.4		460	7.80	198	0.580	0.200	0.127	0.123
	06	35 0035	6.3	5.6		460	7.70	212	0.760	0.060	0.173	0.158
	06	35 0065	4.7	3.0		460	7.50	212	0.630	0.310	0.233	0.223
72/08/19	15	35 0000				420	8.65	174	0.060	0.080	0.026	0.015
	15	35 0004	26.3	12.5		415	8.68	172	0.070	0.080	0.030	0.013
	15	35 0015	21.3	4.4		460	8.00	193	0.100	0.070	0.021	0.011
	15	35 0022	19.3	4.3		460	8.00	208	0.200	0.080	0.023	0.015
	15	35 0030	13.6			490	7.55	200	0.650	0.110	0.065	0.055
	15	35 0037	8.2	3.2		510	7.45	226	1.040	0.070	0.193	0.187
72/11/10	15	00 0000	7.5		161	520	7.90	226	0.250	0.340	0.123	0.111
	15	00 0004		8.3		520	7.90	210	0.250	0.330	0.124	0.116
	15	00 0015	7.5	8.4		520	7.90	216	0.250	0.330	0.136	0.115
	15	00 0025	7.5									
	15	00 0035	7.5	8.4		520	7.90	214	0.240	0.320	0.119	0.111
	15	00 0045	7.5									
	15	00 0055	7.5	8.0		520	7.90	218	0.290	0.330	0.125	0.115
	15	00 0065	7.5									
	15	00 0075	5.8	0.0		520	7.40	230	0.100	1.400	0.374	0.330

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/21	06	35 0000	36.7J
72/08/19	15	35 0000	11.5J
72/11/10	15	00 0000	2.3J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 74/09/30

553102
43 05 12.0 088 23 12.0
LAKE NAGAWICKA
55 WISCONSIN

11EPALES 2111202
3 0003 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/21	07 14	0000	14.2	3.9		540	7.50	275	0.470	0.160	0.362	0.332
72/08/19	15 25	0000	25.3		36	520	7.95	254	0.080	0.070	0.264	0.219
72/11/10	15 35	0000			41	700	7.60	320	2.540	0.270	0.122	0.103
	15 35	0004	6.5	8.4		700	7.60	298	1.870	0.260	0.126	0.109

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/21	07 14	0000	3.3J
72/08/19	15 25	0000	15.5J
72/11/10	15 35	0000	2.9J

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY DATA

STORET RETRIEVAL DATE 74/10/02

553141 L5553141
44 24 00.0 088 24 30.0
BARK RIVER
55 15 HARTLAND
O/NAGAWICKA LAKE
CO HWY C BRDG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/23			0.157	0.900	0.125	0.009	0.04K
72/11/05	13 20		0.220	0.720	0.093	0.065	0.082
72/12/09	13 00		0.340	1.200	0.176	0.084	0.110
73/01/05	13 15		0.460	0.870	0.150	0.105	0.115
73/02/11	13 48		0.730	0.960	0.038	0.091	0.121
73/03/19	10 25		0.950	0.900	0.022	0.075	0.185
73/04/14	15 00		0.940	0.800	0.033	0.086	0.115
73/04/29	15 00		0.670	1.100	0.054	0.050	0.065
73/05/12	14 35		0.470	0.920	0.039	0.037	0.055
73/05/28	15 15		0.480	1.540	0.060	0.018	0.045
73/06/16	13 30		0.240	1.900	0.290	0.022	0.055
73/07/01	13 20		0.200	0.820	0.048	0.005K	0.045
73/08/26	13 15		0.048	1.600	0.056	0.020	0.055

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/02

5531A2 L5553IA2
44 06 30.0 08P 20 30.0
BARK RIVER
55 15 HARTLAND
T/WAGAWICKA LAKE
US 16 BRDG AHV HARTLAND STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/23	13	55	0.390	1.450	0.189	0.078	0.125
72/11/03	14	00	0.160	0.850	0.010	0.013	0.039
72/12/09	13	00	3.400	0.780	0.042	0.016	0.035
73/01/06	13	45	2.400	1.000	0.083	0.014	0.045
73/02/11	14	40	2.800	0.660	0.021	0.016	0.040
73/03/18	10	20	1.120	1.050	0.029	0.017	0.140
73/04/14	13	50	1.580	0.920	0.009	0.009	0.035
73/04/29	13	30	1.300	1.400	0.040	0.015	0.045
73/05/26	14	00	1.120	1.320	0.020	0.013	0.045
73/05/28	14	00	0.260	0.800	0.028	0.008	0.020
73/06/16	13	50	1.060	1.980	0.220	0.046	0.120
73/07/01	10	00	1.540	1.380	0.038	0.026	0.065
73/08/26	13	45	1.900	0.460	0.031	0.022	0.045

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STORET RETRIEVAL DATE 74/10/02

553143 LS553143
44 05 00.0 088 22 00.0
PARK RIVER
SS 15 HARTLAND
I/NAGAWICKA LAKE
ST HWY 83 BRDG BELO HARTLAND STP
11PALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/23	14 10		0.505	2.000	1.700	0.098	0.128
72/12/09	13 20		3.400	1.520	0.350	0.190	0.270
73/01/06	13 30		2.530	1.600	0.330	0.140	0.190
73/02/11	14 00		2.900	1.050	0.168	0.082	0.145
73/03/18	10 10		1.060	1.260	0.105	0.037	
73/04/14	14 00		1.520	1.260	0.260	0.105	0.175
73/04/29	14 50		1.140	1.800	0.160	0.056	0.135
73/05/12	14 30		1.100	3.050	0.230	0.076	0.240
73/05/28	15 02		0.840	1.680	0.132	0.088	0.180
73/06/16	13 45		1.220	3.300	0.390	0.120	0.375
73/07/01	13 35		1.640	1.900	0.300	0.180	0.360
73/08/26	14 00		1.980	1.800	0.640	0.220	0.270